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FOOD FOR THOUGHT - THE USE OF HAZARD AND CRITICAL CONTROL POINT ANALYSIS TO ASSESS VULNERABILITY OF FOOD TO TERRORIST ATTACK IN DEPLOYMENT LOCATIONS, A CASE STUDY

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ABSTRACT:

As part of a case study, a literature review, personal interviews, and a field study at several deployment locations in one Area of Responsibility were completed to examine the historical use of biological warfare agents and the vulnerability of food at military deployment locations to bio-terrorist attack. The results of the study suggest the following: historically, food has occasionally been used as a weapon by individuals; a bench-mark procedure already exists to evaluate and ensure the safety of foods procured and used by the United States federal government; food sources at the deployment locations examined are vulnerable to terrorist attack as determined by a critical control point analysis; and efforts to prevent bio-terrorism employing food have not kept pace with the potential threat to food safety. Recommendations to potentially decrease the vulnerability of the United States military food supply to intentional contamination are also provided.

BACKGROUND:

The history of biological warfare and intentional food contamination events reviewed and presented here act as a backdrop for a field study that examined the potential for intentional food contamination at military deployment locations. The field study involved a review of current food procurement and handling practices at several deployment locations. The practices were examined using critical control point analysis, a procedure used by the National Aeronautics and Space Administration to evaluate procurement and processing of foods used in the space program.

BACKGROUND ON BIOLOGICAL WARFARE:

Pre-WWII

Although no attempts have been documented where food was used to poison US military forces, the threat of biological warfare (BW) has existed since plague infected corpses were hurled over castle walls in the middle ages. In North America, one of the earliest uses of BW agents in wartime was during the French and Indian Wars, when the British gave blankets contaminated with smallpox virus to the Indians with devastating effects (Christopher et al, 1997). Later, during World War I (WWI), the Germans tried to infect Allied horses and mules with anthrax and glanders, a respiratory infection of horses and mules caused by *Pseudomonas mallei* (Clarke, 1968). This incident, along with the widespread use of chemical weapons, prompted the Polish delegation to lobby for the banning of biological weapons in the Geneva Protocol of 1925. The Protocol prohibited the use of both chemical and biological weapons in battle but failed to limit their development, testing and stockpiling (Cookson et al, 1969). The United States, at the urging of the Chief of

the Army's Chemical Warfare Service, did not ratify the Geneva Protocol. Non-ratification had serious and unexpected effects on world events. The US reluctance to ratify the protocol spurred both Japan and Russia to launch extensive biological warfare research programs (Spiers, 1986). World powers saw US hesitation as an indication that this must be a valuable weapon in need of further study.

WWII

During World War II (WWII), both the Axis and Allied powers participated in biological weapons research. Although the US never amassed large stockpiles of biological weapons, research was conducted on the use of both anthrax and botulism toxin (Bernstein, 1987). Following that research, a BW production plant was constructed in Terre Haute, Indiana, however, weaponry production was never started (Mobley, 1995).

The British participated in the testing of BW agents on the Gruinard Islands, off the coast of Scotland. The testing was accomplished using bombs loaded with anthrax against sheep placed on the island during 1942 and 1943 (Harris et al, 1982). The experiment was a great success and the islands were left totally uninhabitable for over 45 years (Aldhous, 1990). The only BW weapons ever known to be manufactured and stored for use by the British were anthrax-laced cattle feed pellets. The pellets were intended for use against various livestock species in Germany but were never used (Bernstein, 1987).

Though both Axis and Allied powers participated in testing of biological agents during WWII, Japan was the only country to employ them. Japan's BW program that attempted to exploit various agents, including anthrax, plague, and syphilis (Cowdrey, 1984) also used Chinese prisoners as test subjects (Harris, 1994). The Japanese used biological

warfare against the Chinese civilian population using food as "bait" to draw victims to the source of the contamination. Planes were used to drop rice and wheat, containing plague infected fleas, over villages on October 4, 1940 (Harris, 1982). Chocolate candies laced with anthrax were given to Chinese children with deadly effects in July 1942 (Cowdrey, 1984).

Korea

The Korean War, unlike WWI and WWII, had no substantiated reports of BW agents. The lack of development and use, however, did not prevent the Korean and Chinese government from making claims about their use for political gain. Both governments claimed that US aircraft had released disease-carrying insects from the air much like the Japanese had done during WWII. The Chinese government even used these claims to start a public health campaign focusing on improved hygiene practices among the Chinese population. No credible evidence of BW agent use by the US was ever produced (Mobley, 1995).

The Cold War and Vietnam Era

Research on the use and effects of biological weapons continued during the Cold War as well. Organizations at Fort Detrick conducted extensive animal testing (Press, 1985) while other American scientists conducted human tests. During September 1950, several tests were accomplished, using unwitting US citizens, by the release of bacteria from ships in San Francisco Bay. *Serratia marcescens and Bacillus globigii*, were thought to be harmless, but one death did occur along with a mild outbreak following the tests (Cole, 1988). In the mid 1960's, Army researchers in New York City dropped light bulbs filled with *Bacillus subtilis* into subway ventilation shafts to assess US vulnerability to BW agent attack. The

agent was quickly spread throughout the subway system, with no action by transit authorities, confirming to investigators the vulnerability of the US to intentional BW attack (Cole, 1985).

BW agents saw only limited used during the Vietnam War. The Vietcong's most sophisticated attempts at using biological agents involved the tipping of punji stakes with feces. Although a primitive use of BW, it was effective, the wounds of those encountering these sharpened stakes quickly became infected, and recovery was prolonged (Mobley, 1995). There were reports during the Vietnam War era of thousands of deaths among both villagers and adversaries of the Soviets living in Cambodia, Laos, and Afghanistan. These deaths were apparently due to "yellow rain", a tricothecene mycotoxin reportedly used by the Soviets and their allies, causing nausea, blistering and death (REFERENCE).

During the Cold War, President Nixon saw the need to address the use of BW agents in war. He began his efforts by first destroying all US stockpiles of BW weapons and then spearheaded negotiations on the Biological Weapons Convention. The Convention drafted a treaty outlawing the use of offensive biological weapons (Press, 1985). Though the convention was agreed upon by world powers, Soviet Block countries were believed to have continued the development of offensive BW capabilities. The Biological Weapons Convention quickly proved outdated with the introduction of genetic engineering and the lack of treaty verification provisions (Mobley, 1995).

After the Biological Weapons Convention, BW agents saw continued use. One of the more famous instances involved the assassinations of two Bulgarian exiles Georgi Markov and Vladimar Kostov. Both were killed with ricin-impregnated pellets fired from an umbrella (Mobley, 1995). In 1979, the former Soviet Union suffered a pulmonary anthrax

epidemic of unknown magnitude. In 1992, President Boris Yeltsin officially claimed government responsibility for the explosion of the top-secret military compound in Sverdlovsk (Kucewicz, 1984). Prior to collapse, the USSR had the largest BW agent stockpile and production capability in the world (Holmes, 1989).

The Gulf War

The Gulf War of 1991 again brought the threat of BW agent testing and use. Intelligence sources and subsequent UN inspection teams confirmed the Iraqis had the ability to produce and weaponize anthrax spores for use against the coalition forces deployed to liberate Kuwait (Begley et al, 1991). These anthrax cultures were imported from the United States and France, while others were produced at the Al Hakam Single Cell Protein Production Plant (Zilinskas, 1997). Iraq tested *Clostridium perfringens*, wheat cover rust, and five human viruses including Congo-Crimean hemorrhagic virus, Yellow Fever virus, Enterovirus 17, Rotavirus and Camelpox virus (Zilinskas, 1997). The Iraqis also weaponized various toxins (botulism toxin, aflatoxin, ricin and tricothecenes) (Zilinskas, 1997). Agents, quantity produced, stored and weaponized by Iraq are shown in Table 1. Delivery systems for BW agents varied and included a modified MIG-21 fighter plane with spray tanks capable of holding 2200 liters of liquid. Table 2 is a breakdown of weapon delivery systems used by Iraq (Zilinskas, 1997). The potential for the use of the BW weapons against the military is obvious, however, the civilian population was also thought to be at risk, because of Saddam Hussein's August 10, 1990 "Holy War" or "jihad" declaration, where all Muslims were to take up arms against the US aggressors (Kirk, 1991).

US INTENTIONAL FOOD CONTAMINATION EVENTS

Very few cases of intentional food contamination have been documented in the United States, however, intentional contamination of food may be considered a form of BW. Contaminated food could have a dramatic on military mission completion or the civilian populace if used as a weapon.

Salmonella typhimurium Type A

One of the most significant instances of intentional food contamination in the United States occurred in The Dalles, Oregon (Torok et al, 1997), where restaurant salad bars and creamers were intentionally contaminated with *Salmonella typhimurium* Type A. After careful investigation and tabulation of extensive food consumption histories from town personnel, salad bar items were implicated in all the restaurant-associated cases of disease.

The 1984 outbreak occurred in two waves: the first wave affected 88 people; 586 cases were identified in the second wave. All but 11 cases were considered primary cases from exposure to the infected food source. The remaining 11 cases were caused by exposure to a primary case. Only 48 of the reported cases did not have adequate information to implicate a specific restaurant. Overall, ten restaurants were implicated in the investigation: two being targeted by the saboteurs during the first wave and an additional eight restaurants targeted in the second wave.

Certain political factors unique to Wasco County became more important as the criminal investigation of the food contamination progressed. The purchase of a large ranch, intended for use as the new international headquarters for Bhagwan Shree Rajneesh commune, created contention about land use among county residents. In an effort to avoid

county oversight, the Bhagwan Shree Rajneesh attempted to incorporate part of the ranch as the city of Rajneeshpuram. County residents blocked these attempts in the courts. It appears that members of the commune believed that influencing the results of a County Commissioners election scheduled for September 6, 1984 might help their efforts to incorporate.

The epidemiological and criminal investigation of 'The Dalles' *Salmonella* outbreak confirmed that *Salmonella typhimurium* cultures grown in the laboratory at the Rajneeshpuram commune were the source of the intentional contamination of food on the salad bars. Based on information provided by an informant, the intent of the intentional contamination of food was to incapacitate the voting populace and thereby influence the election.

***Shigella dysenteriae* Type 2**

Another case of intentional contamination of food with a bacterial pathogen occurred in 1996 (Kolavic et al, 1997). The contamination event involved clinical laboratory workers infected with *Shigella dysenteriae* Type 2. Because *Shigella dysenteriae* Type 2 is a rare organism and outbreaks are seldom seen in the general population, the uniqueness of this outbreak was immediately apparent. Prior to this outbreak, the last reported outbreak of *Shigella dysenteriae* Type 2 was in 1983 among Maryland medical cafeteria workers.

Following consumption of muffins and donuts anonymously placed in the break room of a Texas laboratory, 12 of 45 laboratory workers became infected with *Shigella dysenteriae.* The pastries were consumed on October 29, 1996 and cases reported through the evening of November 1, 1996. Because of the rapid onset of symptoms, investigators were able to

retrieve a sample of one of the implicated muffins left in the break room. Also, due to the uncommon nature of the organism cultured from the ill laboratory workers, the investigation lead to an inspection and accounting of in-house laboratory stock cultures. Laboratory reference cultures were found in disarray and portions of the reference samples had been removed. The bacterial organisms cultured from eight of the patients and also from the single leftover muffin were identical to those removed from the laboratory freezer. This incident underscores the ease with which cultures can be taken, grown and used to contaminate foodstuffs, if desired.

Hepatitis A

Another instance of apparent intentional contamination of food with Hepatitis A was documented in 1965. Twenty-three cases of hepatitis were reported among personnel (one enlisted man and 22 officers) at a Naval Air Station in November of 1961 (Joseph, 1965). Eighteen of the men became ill while still stationed at the Naval Air Station, three of the men became ill while on sea duty, one while on leave and one on temporary duty. The course of the disease among those infected was moderately severe with no deaths. All the patients returned to work an average of 48 days after onset of symptoms. The meticulous nature of military records greatly facilitated the investigation of this outbreak. The cases were typical of "infectious" hepatitis; the onset of symptoms was rapid, beginning with fever, followed in four to five days by dark urine, and later by jaundice. Other symptoms included general malaise, nausea, weakness, loss of appetite, chills, and myalgia, vomiting, headache, abdominal discomfort, and hepatic enlargement.

In the early 1960's, the diagnosis of Hepatitis A (infectious hepatitis) and Hepatitis B (serum hepatitis) was made on clinical and epidemiological grounds. An extensive investigation of risk factors (such as married versus single, squadron of assignment, living on base or off, facilities where patients had eaten, housing) was conducted. Based on military records of personnel eating in the suspect dining facility, investigators concluded the exposure had occurred on either the 26th or 27th of October. Counting from those dates, the average incubation period for the disease was 33 days. Records of Dining Hall menus provided a list of foods served on those dates. Food questionnaires were administered to patients using food menus from the suspected dates. A process of elimination was used for the foods until finally, two foods were identified as being the most likely sources of contamination, ice cream and potato salad. Further analysis identified the potato salad as the most likely contaminated food source.

Although there were 21 food handlers working in the kitchen, only one was responsible for making the salads. Extensive questioning about potato salad preparation was conducted. Questioning of the cook revealed that he had experienced a transient illness approximately two weeks after starting work in the Officers Dining Room. Many of the symptoms of hepatitis were listed among his complaints. A further background investigation of the individual revealed aberrant social behavior. He had a history of inappropriately urinating on things. Two incidents of inappropriate urination gave investigators a possible route of contamination of the potato salad when coupled with the individual's history of symptoms resembling hepatitis. Though the "Control of Communicable Diseases Manual"

does not mention urine as a means of transmission of Hepatitis A, it does say that "sanitary disposal of feces, urine and blood" from infected patients is recommended (Benenson, 1995).

Ascaris

The last instance of intentional contamination involved four college students who were unknowingly exposed to a massive dose of embryonated *Ascaris suum* eggs while attending a Winter Carnival in Canada during February 1970, (Phillis, 1972). Following an incubation period of approximately two weeks, the students presented at the Emergency Department of their local hospital, exhibiting lower respiratory tract symptoms ranging from mild dyspnea to acute respiratory failure.

The chest radiographs from all four patients revealed lung involvement ranging from mild nodular densities to marked pulmonary infiltrates. Elevated eosinophil counts were seen in some of the patients at admission and became more marked as the disease progressed. The diagnoses of Ascaris infection were made in a variety of ways: larvae were demonstrated in sputum and gastric washings of two of the patients; immature worms were found in the feces of another; and finally, IgM antibodies to *A. suum* antigen detected using agar-gel diffusion and immunoelectrophoretic techniques. All but one of the patients was treated symptomatically with steroids for the pulmonary inflammation and all were given piperazine prior to the expected adult stage, killing the parasites.

No additional information was available on the method or motive for this cluster of infections, but it is a highly unusual occurrence in this setting. The most likely source of infection was a meal served to the students during a Winter Carnival.

The four instances of intentional contamination represent all the occurrences of intentional contamination cited in the current literature as of 1999. The outbreaks ranged from small numbers to relatively large outbreaks and illustrate how vulnerable the US population is to intentional contamination. The large-scale outbreak of *Salmonella typhimurium* involving 'The Dalles' shows how this type of terrorism can be used for political gain by incapacitating large numbers of residents and precluding them from casting their vote in an election. Had this same type of contamination occurred in a major metropolitan area, and multiple large restaurant salad bars been contaminated, it is easy to assume that literally thousands of people could have been infected. Had a different agent been employed such as anthrax, the results would have been catastrophic.

The example of laboratory workers intentionally infected with *Shigella dysenteriae* Type 2 demonstrates how easy it was for a disgruntled employee with access to infectious agents to steal and subsequently use laboratory specimens or stock cultures to perpetrate an intentional contamination event. These same samples could have easily been mixed into a school cafeteria ice cream machine, or commercial food preparation plant with a wider distribution base.

The Naval Air Station infectious hepatitis outbreak points out that even in controlled food preparation facilities, like a military installation, intentional contamination is easily accomplished. With the mass preparation of food as occurs with military deployments, contamination of one of the main courses could greatly impair mission accomplishment: large numbers of personnel eat in a limited number of dining facilities with a small number of menu choices.

The final instance of food contamination among Canadian college students demonstrated the wide variety of potential agents available for use as an intentional contaminant of food. The case series also elucidates the potential difficulty in determining early the precise etiologic agent involved; how many people may potentially be affected; and the variability of clinical signs and symptoms as the patients arrive for treatment.

INTRODUCTION:

Several government agencies are tasked with protecting the civilian population against food contamination, including the US Department of Agriculture and the Centers for Disease Control. These two organizations have been concerned primarily with unintentional food contamination from improper processing, transportation, or preparation.

Another organization, the National Aeronautics and Space Administration (NASA) has historically maintained an exclusive food safety program designed to deliver a safe and nutritious food supply for space flight (Heidelbaugh et al, 1971). A systematic approach for determining contamination potential, using the Critical Control Point technique, has been used by NASA to ensure the safety of food served in space. In the technique, Critical Control Points (CCP) are identified throughout the process of procurement, processing and delivery of food into space. CCPs are defined as a locus in the food processing where there exists a measurable attribute that has a significant influence on the quality or wholesomeness of the final product. Once a CCP was identified by NASA, the products were tested, at that point, for either acceptance or rejection. Acceptance or rejection was based upon a group of test procedures and a testing plan developed for each CCP (Heidelbaugh et al, JAVMA, 1973).

While the space program has much greater constraints to work under, many of the principles could, as suggested by NASA food technologists (Heidelbaugh et al, JAVMA, 1973), be used to improve the overall safety of the US food supply. Further, because of its systematic approach to analysis of a process, or series of processes, the Critical Control Point analysis technique might serve as a benchmark for protecting our military forces against intentional food contamination. The purpose of the current study was to determine the CCP

analysis techniques' usefulness in the field and the potential for intentional contamination of food at 3 deployment locations.

During a deployment to theater, the first Food and Water Vulnerability assessments to identify risk of intentional contamination of food and water by biological agents were conducted. Vulnerability assessments at each facility were directed by the Joint Task Force Commander (JTF) and completed by members of a medical surveillance team (an Air Force Bioenvironmental Engineer and technician, a Public Health Officer, and a Flight Surgeon) and base team comprised of Contracting, Services, Force Protection, Transportation and Office of Special Investigations personnel. Each member of the team provided specific expertise about unit functions, used during the food and water vulnerability evaluations. The request for the assessments was prompted by JTF's concerns about the safety of multi-national forces under his command in the Area of Responsibility (AOR). The assessments at three large facilities are detailed in this document.

METHODS

Assessments were completed for food procurement and food handling and documented at each of the three facilities. Analysis of each process was completed using Critical Control Point Analysis ( ).

RESULTS:

Two main portions of the food supply process were identified; food procurement and food handling. Food procurement was further subdivided into contracting, source identification and transportation. Each of the subdivisions represented a critical control point

for analysis. Each critical control point was then considered a vulnerability. Figure 1 shows a simplified diagram of the food procurement process in theater.

Food Procurement:

Contracting: The majority of food served in the dining facilities in theater was provided through a contract with Contractor A, a large food wholesaler and food service company. Department of Defense (DOD) contracting agents negotiated these contracts with the wholesaler. A contract was also in place to purchase food from the Defense Supply Center Philadelphia warehouse, located within the United States. The governments of the respective countries where Base A, Base B and Base C were located provided the financial support for these contracts. Though apparently well written, the contracts provided requirements only for the logistics and legalities of food delivery but lacked attention to many pertinent food safety issues.

During the assessments several specific problems were noted with these early stages of food procurement. Contracting personnel were found to have no rejection authority for incoming food. Because there was no rejection authority, US contracting personnel occasionally had to accept foods past their expiration date or that were visually unappealing.

Food source identification: Source identification involves identifying and selecting the suppliers of foodstuffs. Contractor A contracted to provide fresh produce, dry goods, and many other staples required for food preparation. Most of the fresh produce was purchased off the local economy, which included neighboring countries, hostile to United States interest. Other foods were purchased by Contractor A more regionally, and stored at a centrally located warehouse for distribution. Other foodstuffs, such as , were processed by

United States food manufacturers and stored at the DSCP warehouses before shipment to theater.

During this assessment, foods were periodically accepted from sources that had not received a formal military inspection or were unapproved. Although Contractor A identified several sources as acceptable, the United States military did not. Specifically, fresh fruits and vegetables were obtained from countries hostile to the United States. Receipt inspections, upon receipt of food from Contractor A, were only periodically conducted. Therefore, suppliers knew there was only limited potential for inspection.

Transportation: The centrally purchased food was shipped predominantly via semi-tractor trailer truck from the centrally located warehouse to Bases A, B and C. Locally purchased food was transported to Bases A and C via small truck. The trucks used during transport were deemed unsecure, as virtually anyone the drivers allowed, had access to the provisions. Local government inspections for contraband were completed along major roads at numerous locations within the theater. During these stops, the inspectors required drivers to open their trucks, again allowing access to the provisions. The DSCP food was transported via commercial (boat/plane) to the theater and transported to Bases A, B and C to by large truck. Transportation and loading/unloading procedures for these foodstuffs were usually accomplished by the truck drivers and there was no direct US government oversight. No mechanism was in place to determine who exactly had access to foods during transport.

Food Handling:

Food handling was identified as a critical control point and was further sub-divided into the areas of storage, preparation, serving/distribution, clean-up, and personnel. Each of

the sub-divisions is a step in the process of delivering the food from procurement to the military dining table. The steps in food handling are shown in Figure 2.

Storage: Storage involved keeping small to medium quantities of food at the base for later use. Generally, food to prepare ( ) days of meals was kept on the base. Additionally meals ready to eat (MREs) for ( ) days were also maintained in storage away from the dining facilities. Storage areas included wooden-floored temper tents, hard sided-temporary buildings, refrigeration and freezer units.

Some storage areas were normally found unlocked and readily accessible to anyone in the general area. At other storage areas, Services personnel did not have access - only the TCNs had keys to locks in place. TCNs entering storage areas were no always supervised.

Preparation: Preparation involved handling, mixing, and cooking foodstuffs before serving to personnel. Preparation of food was accomplished in wooden-floored temper tents and hard-sided temporary buildings. Mixing kettles, cutting boards, soft ice cream machines, ovens, stoves, and standard utensils were used to prepare foods. Personnel preparing foods were only periodically monitored by Services personnel.

Serving/Distribution: Serving/distribution included putting food onto the serving line, placing food into boxes for boxed lunches or placing food on trays for transport to more remote eating locations. Most food at the bases studied was served from a steam table directly onto stainless steel trays. Self-serve salad bars, soft drink machines, toasters and soft ice cream machines were also in place.

Clean-Up: Clean-up included the washing of trays, pans, preparation and eating areas. Personnel performing clean-up were only periodically monitored by Services personnel.

Personnel Selection: Personnel selection includes the selection and maintenance of personnel employed to help store, prepare, or serve food or clean-up food use areas. Service personnel were generally not used for any portion of the food handling process but, instead were used as supervisors and quality control inspectors. Usually only one or two Services personnel were on duty at any time in each dining facility. At well-monitored sites, the ratio of Services personnel to TCNs was about one to five. At other sites the assessment revealed ratios as high as one to twenty-five. It was also learned that TCNs working in commercial (Army Air Force Exchange System) facilities on bases were not routinely monitored at all. Personnel from Services cycled through the facilities on a regular basis but did not continuously observe TCN actions in the dining facilities. Personnel performing the actual food handling in the deployment location were predominantly Third Country Nationals (TCNs), brought to the deployment location from surrounding countries. The TCN home nations were generally allied with United States interests. TCNs were housed in their own tent cities outside the main base areas where US troops were housed. In general, the TCN living conditions were unsanitary and far below United States poverty housing. Living areas had no interior running water, most water was drawn from common wells, TCNs were housed with several individuals per room, and no utilities or electricity was the norm.

DISCUSSION:

Food Procurement:

Contracting: With the arrival of the first deployment teams to the deployed location, contracts were let and food procurement began. The most pressing problem found was the lack of rejection authority afforded military food inspectors. Though the lack of inspection/rejection authority has been a common problem through the history of food procurement ( ), the deployment locations studied presented a slightly different situation. In the past, those responsible for procuring food for US forces were US military personnel who were not seeking a profit by providing food to troops. The primary responsibility of the military food Services personnel was to serve good, wholesome food to their fellow service members. In the case of Contractor A, they were providing much of the food and were solely responsible for food procurement, while simultaneously trying to make a profit. The need for profit apparently caused the contractor to use foods that were past their expiration date and of questionable quality, possibly compromising food safety. To protect against intentional contamination, contracts must contain rejection authority and training of contract personnel about associated procurement issues must be accomplished.

Source Identification: Other problems identified by the assessment teams were the lack of contractual requirements that food be from military inspected and approved sources only; and the lack of inspection authority for facilities contracted for meal preparation. Again, these problems are nothing new ( ) but demonstrate a lack of vigilance on the part of the US military in protecting itself against intentional food contamination. Food processing plant inspections should be completed and approved before contracts are written.

Because during the vulnerability assessments questionable growers and suppliers of food were identified; care in selecting suppliers must be taken during the contracting phase of food procurement, as well as continued monitoring of contract compliance to ensure that food sources are considered safe. Receipt inspections must be accomplished to ensure the contractor is not using food from unapproved sources. Receipt inspections increase suppliers' awareness that the food is being inspected for intentional contamination, as well as wholesomeness. Even sporadic inspections give the perception that the food supply is being monitored. Special care must be taken during procurement not to purchase foods that have already been intentionally contaminated prior to purchase.

Transportation: Transportation of food supplies from the vendor to the actual deployed site allows a potential window for intentional contamination. To overcome this threat of intentional contamination, some "chain of custody" for the food intended for consumption by US military personnel should be maintained. At a minimum, the contracts should require some sort of "seal" protocol be in place to help eliminate or at least reduce the accessibility of the food and the potential for contamination during transportation. A seal protocol requires early thought and might require a trusted agent be placed at the point of origin to inspect/oversee the placement of a metal or plastic seal on the truck door. Seals could be numbered and could only be removed by the receiving agent. The number would be placed on the bill of lading and this would be matched with the unopened seal. A potential difficulty with the seal protocol would be driver stopping for other drop-offs and the vehicle inspections on main highways, completed by the host nation.

Food Handling:

Storage: Once food arrives at a military installation, both non-military and military personnel have unfettered access to storage locations placing stored food at risk to intentional contamination. Positive control of these storage facilities should be maintained at all times by the use of locks and supervision of personnel entering the storage locations.

Preparation: Food preparation affords a great opportunity to add a contaminant to food. TCNs have direct access during food preparation and even with close monitoring could contaminate the food or drinks such as milk or juices prepared from powders. Foods that are most vulnerable to contamination are those that are not intended to be cooked, such as salad bar items. These require extensive processing (i.e. contact with human hands) and are never cooked. Any bacteria or contaminant introduced has no chance of being killed by cooking as with hot foods. These items are often prepared in large quantities and lend themselves well to contamination. Special vigilance must be maintained when it comes to these items especially, but all items should be closely monitored for intentional contamination.

Serving/Distribution: The process of serving food was monitored by US military personnel but food was still deemed to be vulnerable to contamination at this stage. Once initial cooking was completed, food on the serving line was not maintained at high enough temperatures to kill most pathogens ( ). At this point, a contaminant could be added with greatest chances of causing illness. The salad bar, soft serve ice cream and soft drink machines are especially vulnerable to contamination during serving, since no cooking or even heating is routinely done with these foods.

Clean-Up: Though often overlooked as an area of potential contamination, cleanup is a very important point of the food service process. Like most food preparation tasks, TCNs also accomplished this task. This facet of food preparation requires continuous monitoring, since the dishes, trays, and utensils are in direct contact with food. TCNs should not be allowed to accomplish this task unaccompanied, since pathogens or toxins could be

introduced to the food contact surfaces during this process, allowed to dry and later be activated when foods are served.

Personnel: Historically this task has been done by military members but are now frequently contracted out. During recent deployments TCNs have been used for labor intensive task such as food preparation. With the true allegiance of many of these workers unknown, every attempt must be made to prevent them unfettered access to our food. The one to five ratio of Services personnel to TCNs observed at most sites is probably acceptable, however, bases provided TCNs easier access to the food than was prudent. Vulnerable areas included places like salad bars, were TCNs had unrestricted access to the food with minimal supervision.

Simple steps that reinforce good sanitation could help to prevent TCNs from contaminating foods. Showering into the base (i.e. arriving at an entry control point, removing their clothes, showering and donning clothes provided by the military and being allowed to bring nothing in from the outside) would help to eliminate the risk of TCNs bringing a contaminant onto the base. Allowing or requiring the TCNs to eat the food they prepare would help to decrease the likelihood of intentional contamination and prevent the current practice of TCNs being allowed to bring in their own meals. Carrying their own meals offers them an opportunity to bring contaminants onto base to contaminate food supplies.

The first critical control point to be considered when forced to use TCN labor is the contracting document that defines their conditions of employment. Contracting agents should be well informed about food safety issues as they relate to the risk involved in using

foreign national laborers and the specific contract language that should be used to help ensure the safest possible situation. Though both Services and medical personnel often support contracting officers, the level of experience varies widely from contingency to contingency. The most sensible approach to solving this problem is a systematic, well planned approach that incorporates the knowledge of the most experienced personnel from the three disciplines; contracting, Services and the medical community. Standardized contract wording could be developed and then taught at each of the three technical schools to new and existing personnel and included in all contracting deployment packages.

While contracting plays an important role in the initial phase of procuring the TCN labor force, once a good contract is written, only half the work is done. The day-to-day monitoring of TCNs is mostly left to Services. Simply telling Services personnel to "watch" these people (TCNs) is wholly inadequate. Services personnel, like their contracting counterparts require additional training, this training should help them to understand how to be good observers and should increase their index of suspicion for intentional contamination. The training should also be incorporated into technical training and refresher courses at the military Services schools.

Dining Facility Use: Currently, military leaders feel compelled to provide hot meals, often increasing the risk of foodborne illness and intentional contamination in an attempt to maintain morale. This puts the issues of force protection and morale at conflict. The question is, are these meals really necessary? Do the troops really need freshly prepared meals each day, including high-risk foods such as fresh eggs for breakfast and salad at other

meals. Quality of life for military members already forced to be away from their homes and families, is an issue of great importance. The risks and potential repercussions of having an entire base disabled by intentionally contaminated foods are equally important. Rations such as tray packs or MRE are a viable, if less palatable option, than hot meals served at a dining facility.

Deployment Surveillance: Lessons learned from each deployment should be well documented and attempts made to incorporate these lessons into field guidance should be taken seriously. Conducting business continually in the same manner without incorporating new information from each deployment is a luxury we cannot afford when it comes to intentional contamination of foods. With lives at stake, those lessons will be costly to learn and devastating to repeat.

Though every attempt must be made to prevent intentional food contamination, we must be prepared for the possibility that it could occur. Deployment surveillance is the responsibility of the Theater Medical Surveillance Team in the SWA AOR. They collect and compile weekly disease surveillance reports for all sites in SWA, looking for disease trends and especially increased rates of disease that could be due to biological warfare. Early detection is vital, and work is now underway to make this a real-time reporting system so that disease trends can be evaluated continuously. This next step is important to attain due to the time sensitive nature of the information. The ability to identify and respond quickly and correctly to instances of intentional contamination is nearly as important preventing their occurrence.

SUMMARY/CONCLUSIONS:

In the days since the chemical attack on the Tokyo subway system and the bombings of the Federal Building in Oklahoma City and the World Trade Center in New York, the threat of Biological Warfare has been taken more seriously by leaders in the US. An entire issue of the Journal of the American Medical Association (August 6, 1997) was recently dedicated to biological warfare. Danzig et al, (1997) contends that as a country we must realize that nations are not the only participants in terrorist activities. Simon (1997), points out that organizations/individuals must accept the reality that we will not be able to prevent every act of BW terrorism. Additionally, only by planning and investing in the right training and defensive measures can we diminish the likelihood that biological weapons will be used and reduce the risk, disruption, and casualties in the event that such weapons are used (Danzig, 1996).

The professional literature as well as world news coverage indicate that biological warfare may be employed and food could potentially be used as a weapon of that biological warfare. Numerous food supply vulnerabilities to the threat of contamination at three deployment locations were identified using the Critical Control Point technique and a very limited amount of time and resources. Many of the vulnerabilities identified were easily correctable, again, involving a minimum of monetary resources and time. Others, such as contract modification, would require additional effort to bring to fruition. This study shows, that HACCP analysis can be used to identify process in food procurement and food handling at deployment locations that are vulnerable to terrorist attack. Medical or base commanders at CONUS or deployment locations may wish to form a working group to determine whether

their food supplies are vulnerable to attack, considering each of the critical control points, rather than waiting to react to an incident of intentional food contamination.

Figure 1. Food procurement in theater.

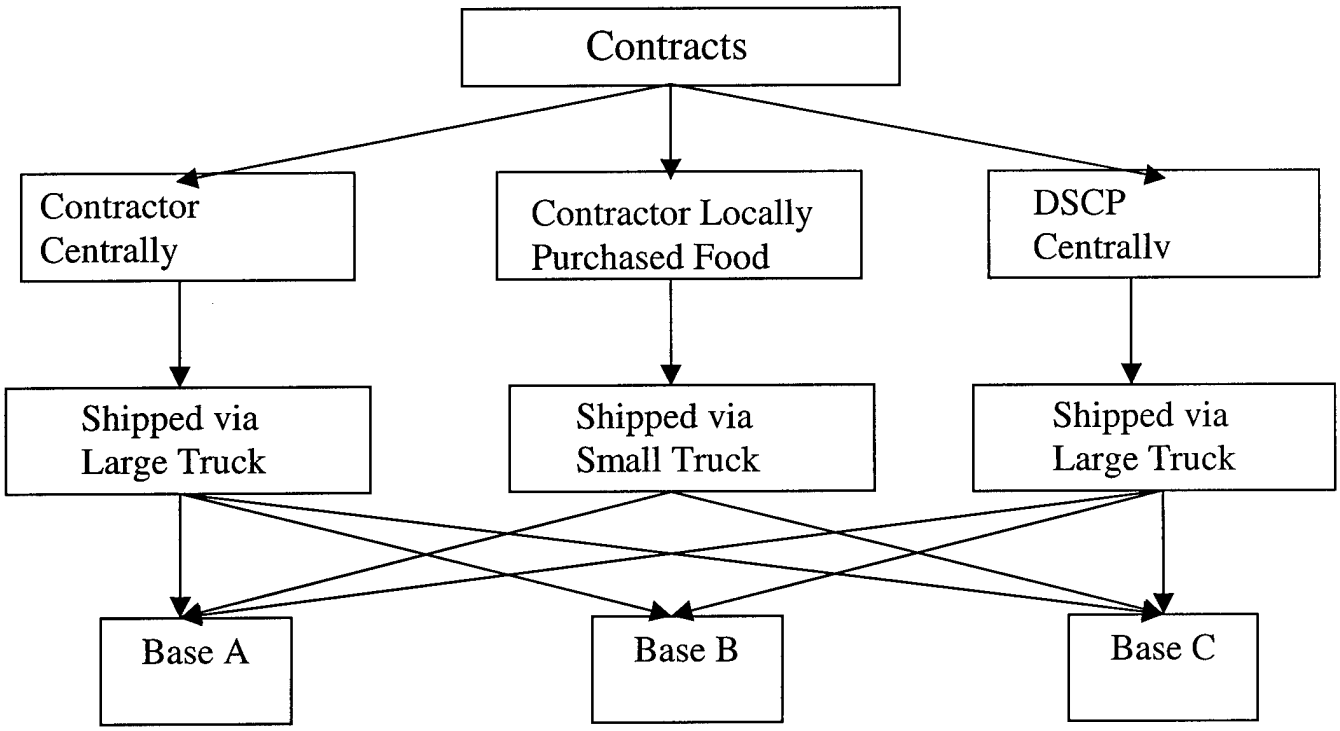

Figure 2. Food handling process in theater. Personnel selection impacts each step in the food procurement process.

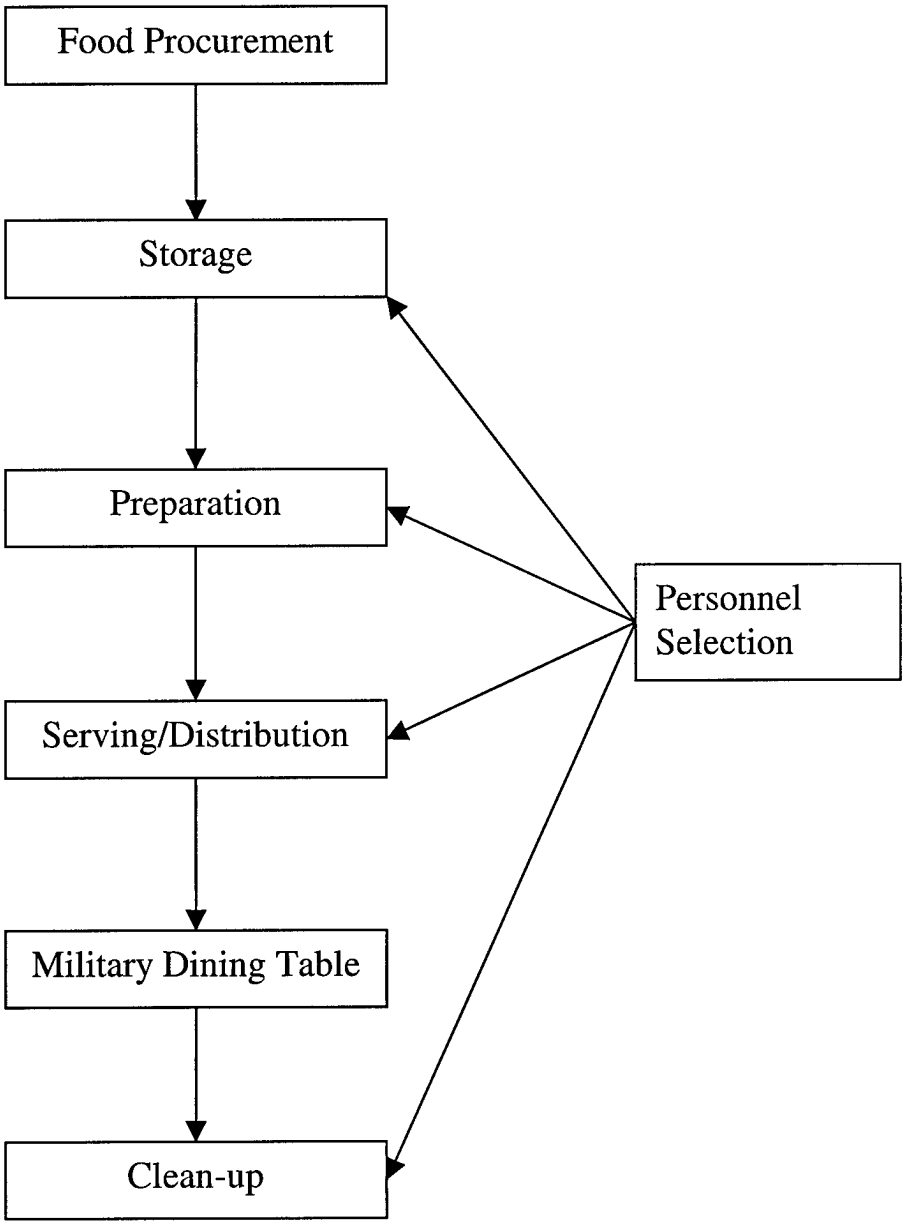

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Table 1. Agents Produced, Stored or Weaponized by Iraq (Zilinskas, 1997)

Agent	Produced (L)	Stored (L)	Weaponized (L)
Bacillus anthracis	8,000	2,000	6,000
Clostridium perfringens	340	None	None
Aflatoxin	2200	Unknown	Unknown
Clostridium botulinum	20,000	8,000	12,000
Ricin toxin	10	Unknown	Some
Tricothecenes mycotoxin	0.020	Unknown	Unknown

Table 2. Agents and Weapon Systems Loaded for Use (Zilinskas, 1997)

Agent	Type Munition	Number Produced
Botulism Toxin	R-400	100
Bacillus anthracis	R-400	50
Aflatoxin	R-400	7
Botulism Toxin	SCUD	13
Bacillus anthracis	SCUD	2
Aflatoxin	SCUD	10